Biological Monitoring of Macroinvertebrate Communities to Assess Acid Mine Drainage

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Keywords: acid mine drainage, macroinvertebrates, biological monitoring, species composition, water quality

Acid mine drainage (AMD) occurs when pyrite and other iron-rich sulfide minerals associated with metal deposits and coal seams are exposed to water and oxygen. A series of chemical reactions result in highly acidic mine water discharges and elevated concentrations of dissolved metals. These discharges are often characterized by high-frequency diurnal variations and seasonal effects. AMD results in alterations in the abundance, taxa richness, diversity, and species composition of aquatic organisms (fish, macroinvertebrates). This paper identifies changes to the benthic macroinvertebrate community in streams affected by AMD.

AMD effects depend on several variables including geology, geochemistry of the mine site (overburden, ore body), and baseline population dynamics. At pH levels lower than 6, trace metals (e.g., arsenic, cadmium, copper, mercury) increase in solubility and bioavailability. Moderate AMD conditions (pH 3 to pH 6) often cause a shift in benthic macroinvertebrate communities dominated by acid/metal-tolerant organisms. Severe AMD (pH < 3) is detrimental to almost all macroinvertebrate populations. Downstream of AMD discharges, acidity is neutralized by dilution or buffering, which increases oxidation through changes in both geology and organic matter. Increased oxidation causes the precipitation of metal hydroxides onto the stream substrate, thereby reducing viable habitat and oxygen supply to benthic macroinvertebrate organisms and fish.

Quarterly or monthly water quality sampling alone may not accurately reflect acute changes in the frequency and range of pollutants discharged from AMD sites. Thus, biological monitoring of macroinvertebrate communities can provide a management tool for assessing AMD discharges and contribute to understanding the range of AMD effects on aquatic ecosystems.